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Skill formation in wealthy nations: Organizational evolution and economic consequences

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Skill formation and economic development

Central to the wealth of nations are the development and utilization of the skills of people. Skills enable people to make technologies and organizations function to produce goods and services. Skills can also be used to generate technological and organizational innovations that produce goods and services that are higher quality and/or lower cost than were previously possible. These innovations often devalue some traditional skills, but also create demand for new combinations of existing skills or entirely new skills.

The process of skill formation is **continuous**, **cumulative**, and **collective**. It is continuous because skills that are not utilized will deteriorate, thus losing their value as productive assets. It is cumulative because the development of new skills builds on a base of existing skills. It is collective because, as the process of skill formation becomes more continuous and cumulative, it becomes necessary to plan and coordinate the development and utilization of specialized skills through integrated organizations.

Over time, continuity, cumulativity, and collectivity make the process of skill formation ever more complex. To transform investments in skills into competitive advantage, enterprises, regions, and nations must plan and coordinate the skill-formation process. To attain and sustain a high level of wealth, enterprises, industries, regions, and nations must have both **strategies** for skill formation and **structures** to implement these strategies. To generate competitive advantage on the basis of investments in physical and human capital, a strategy and structure of skill formation must create value -- products that people want at costs they are willing to bear.

Continuity, cumulativity, and collectivity make skill formation a political process that varies across nations and over time. Skill formation requires investments in the productive capabilities of people, and different societies have different strategies concerning the allocation of these investments across the population. We shall argue that **strategic differences in national systems of skill formation reflect structural differences in the social organization of nations**, including the social organization of business enterprises that form the core of national economies. We shall also argue that an understanding of skill formation as both an investment process and a learning process is essential to understanding changes in the competitive advantage of nations and enterprises.

This paper provides a general analysis, based on a synthesis of considerable empirical evidence, of the causes and consequences of differences in the process of skill formation in four wealthy nations -- Japan, United States, Germany, and Britain -- in the post-World War II decades. First, we provide a general perspective on the strategy and structure of skill formation in major industrial enterprises in each of these nations during the past few decades. Then we look at the historical evolution of the skill-formation systems in these four nations to gain insights into the problems and possibilities of restructuring a previously successful skill-formation system when it no longer yields competitive advantage. Finally, we outline the implications of the

comparative analysis of systems of skill formation for understanding changes in international competitive advantage.

The strategy and structure of skill formation

1. Strategy and structure

For any individual, skill formation occurs through some combination of training and experience. To set the skill-formation process in motion, someone has to decide that it is worth investing in skills. In some cases and for certain types of skill, this strategic decision is made by the individual in whom the skills will reside. In other cases and for other types of skills, however, the strategic decision to invest in skills can be made by those who control the resources of an organization -- a government, a trade association, an enterprise -- that has an interest in the skill-formation process.

As a general rule, the more complex (continuous, cumulative, and collective) the skill-formation process, the more will the decision to invest in skills have to be undertaken by an organization rather than an individual. Complexity increases the need for planning, coordinating, and sustaining the skill-formation process across people and over time. Thus, the costs entailed in skill formation transcend the financial capabilities of individuals involved in the specialized division of labor. The extent of the financial commitment required for skill formation for modern industry demands a collectivization of financial resources.

The complexity of the skill-formation process also demands that the strategic decision makers who allocate financial resources to investment in human and physical capital have a strategy for putting in place the technological and organizational structure of the skill-formation process that will be required to achieve desired goals. This strategy will entail investing in certain types of skills, in certain types of people who will possess these skills, and in certain types of relationships among people who will have to develop and utilize their skills collectively.

The most successful industrial economies have relied heavily, although by no means exclusively, on private-sector business enterprises to plan the strategy and implement the structure that results in skill formation. A common organizational characteristic of these business enterprises is the distinction between management and labor. An extreme view of this distinction, shaped by largely erroneous views of the centrality of Marxian exploitation and Tayloristic rationalization to advanced capitalist development, is that managers think (conceive) and workers do (execute) [the classic modern statement of this point of view is Braverman 1974; for an extended critique, see Lazonick 1990]. The extreme view ignores the importance to the development of capitalist economies of a) managerial structures, in which over the course of their careers, employees learn to think by doing a variety of tasks, thus making the transition from technical specialist to managerial generalist; and b) the integration of thinking and doing on the shop floor as part of an organizational strategy to develop and utilize increasingly complex technologies.

The complexity of the learning process requires that all modern enterprises have a hierarchy in which some people are more involved in thinking and other people are more involved in doing. What makes organizational, as distinct from simply

individual, learning possible, however, is the organizational integration of the specialized activities of those involved in the learning process. Organizational integration in turn requires that everyone in the learning process think about what they do, and that those further up the hierarchy who plan and coordinate the work of other specialists think about what these other people do as well.

As our cross-national comparisons of the strategy and structure of skill formation within enterprises in Japan, United States, Germany, and Britain will show, the organization structures of business enterprises that generate organizational learning have evolved over time, with "organizational integration" as the dominant determinant of long-term changes in competitive advantage. Organizational integration is a set of relationships among participants in a specialized division of labor that permits their activities to be planned and coordinated to achieve common goals [for an elaboration, see Lazonick and West, forthcoming]. For the business enterprise engaged in competition for product markets, organizational integration permits the specialized division of labor to generate higher quality and/or lower cost products than the enterprise has previously been capable of producing. Organizational integration provides the capability to learn as an enterprise, and often as a group of enterprises, and the potential to innovate in market competition.

At the same time, organizational integration is a costly process. To build the relationships among participants in the specialized division of labor that are the social substance of organizational integration requires substantial commitments of resources over sustained periods of time. The high fixed costs of building these relationships will place the enterprise at a competitive disadvantage until such time as the learning process, generated by these relationships, yields returns. The prospects of returns, moreover, are always highly uncertain, in part because the expected learning may not occur and in part because even when it does occur this learning may not be sufficient to meet the challenge of more innovative competitors [see Lazonick 1991:chs.3,6]. The building of the relationships that constitute organizational integration must, therefore, be strategic -- investments in organizationally integrated structures must ultimately generate the high-quality and/or low-cost products that make these investments economically worthwhile. Otherwise these investments will result in competitive disadvantage rather than competitive advantage [see Lazonick 1991:ch.3].

In the cross-national comparisons of skill formation, we shall start with the case of Japan. The current Japanese system of skill formation is the most powerful that the world has yet seen. As such, it is a benchmark against which to evaluate the skill-formation systems in other industrial economies -- even in economies such as those of United States, Germany, and Britain that have in some industries and in certain periods been world industrial leaders.

Next we compare the Japanese system of skill formation with that of the United States, the national economy whose prior industrial leadership has thus far been most challenged by the Japanese. An understanding of the role of organizational integration within managerial structures of major American enterprises in U.S. industrial development permits us to comprehend the Japanese challenge as a more organizationally integrated elaboration of the previously successful American model. The potency of the Japanese competitive challenge resides in the ability of Japanese

enterprises to transform themselves from low-cost producers for low-quality markets to low-cost producers for high-quality markets, thus enabling them to challenge the world's most advanced industrial enterprises for market share.

Up until recently, Germany has been less vulnerable to the Japanese challenge than the United States. Unlike the United States, the competitive strategy of German enterprises had been to produce for high-quality markets in which cost competition has not been paramount and for which the Japanese had not yet learned to compete. As Japanese enterprises have learned how to produce high-quality, low-cost products, Germany's high-quality, but high-cost, strategy has become vulnerable [see Herrigel and Sabel 1994]. The issue now is whether German enterprises can effect the organizational transformations necessary to make the transition from high-quality, high-cost to high-quality, low-cost production.

If the organizational integration of Japanese enterprises is a competitive benchmark for American and German enterprises today, the organizational integration of American and German enterprise was a competitive benchmark for British enterprises many decades ago [see Elbaum and Lazonick 1986]. Both the United States and Germany underwent managerial revolutions that Britain failed to emulate [Chandler 1990]. Lacking a strategy and structure of skill formation that could generate high levels of organizational learning and productivity, British enterprises and the British economy as a whole engaged in a century of relative economic decline. As a European nation with a low-wage but educated, labor force, Britain has provided a base for Japanese investment that can generate high-quality, low-cost products with easy access to European markets. More than anything else, it is the strategy and structure of Japanese enterprises located in Britain that is transforming the British industrial landscape [see Oliver and Wilkinson 1988].

2. Japan

Until quite recently, the competitive strategy of Japanese industrial enterprises has been to be the low-cost producer in the markets that they enter. The Japanese have not, however, sought to achieve this objective by keeping down the price of labor and hence standards of living. Rather (and this strategy goes back to the Meiji period [see Lazonick and Mass 1994]), they have sought to compete by eliminating waste in the form of underutilized materials and machines from the production process. To do so has required investing in high levels of skill, and leaving considerable initiative with workers, on the shop floor.

To maintain the flow of work in the production process while pursuing this competitive strategy of eliminating waste, the Japanese have been compelled to focus on the quality of materials and machines. Over time, this attention to quality has resulted in a process of skill formation that initially allowed the Japanese to take the lead in low-cost production, and then enabled them to shift progressively into higher quality market segments. To do so on a sustained basis, the Japanese have increasingly invested in basic research in contrast to their prior practice of borrowing basic science and technology from abroad. Despite high real wages and a high exchange rate -- both manifestations of the success of the Japanese strategy over the past few decades -- Japanese enterprises are now positioned to be the low-cost producers in many high-quality markets -- luxury automobiles and sophisticated

machine tools to name two -- where they are going head-to-head with not only the Americans but also the Germans.

What is it about the Japanese system of skill formation that enables them to pursue this low-cost, high-quality strategy? The answer to this question begins with the goals and skills of those who make strategic decisions in Japanese industrial enterprises. These strategic decision makers are professional managers who have spent their careers working their way up and around their companies, thus making the transition from technical specialist to managerial generalist. Those managers who make it to the top, where strategic decisions are made, are able to remain in powerful and prestigious jobs after the normal "retirement" age of 55 to 60 that applies to other employees, including most middle managers. By virtue of their own career strategies, and not by virtue of ownership stakes, these top managers have firm commitments to the sustained growth of their companies (which are typically part of larger enterprise groups) and have control over internally generated financial resources needed to ensure this sustained growth.

Owners have little if any control over Japanese enterprises. Through cross-shareholding, businesses own shares in other businesses but neither sell these shares to reap capital gains nor demand substantial dividends. In effect, the cross-shareholding movement (which remained solid in the late 1980s despite unprecedented speculation in the minority of shares traded on the Tokyo Stock Exchange) has negated the traditional power of property to dictate the strategy of Japanese industry.

The career paths of virtually all managers in Japanese industry give them broad knowledge of the technologies and organizations in which their enterprises are involved. Recruited from universities (many of which have special ties with particular Japanese companies) in which the vocational content of education is minimal, Japanese managers spend the first ten years of their careers as white-collar workers rotating among functional departments, geographic locations, as well as companies that are part of their enterprise groups (keiretsu). During these ten years, they are paid seniority wages and collective bonuses, both of which encourage teamwork.

Fundamental to this process of organizational learning is the institution of permanent employment, to which the vast majority of male workers in the major enterprises have access. Permanent employment provides the highly credible promise of employment with the company from the termination of one’s formal education to old age (even if the years after the "retirement" age of 55 or 60 are spent working at lower pay and with less authority in a satellite enterprise of one’s company).

Permanent employment is not contractual, but is ensured by the existence of enterprise unions in all the major Japanese corporations. Membership in these unions includes not only all male blue-collar workers who are regular (as distinct from temporary) employees but also all male white-collar workers, most of whom will, after ten years, join the ranks of management. This joint membership of white-collar and blue-collar workers in the enterprise unions is a powerful force for the integration of management and labor, not only because future managers align their

interests with labor but also because current managers need the cooperation of future managers.

Cooperative management-labor relations, moreover, make both groups better off by enabling high levels of development and utilization of productive resources [see Lazonick 1990]. Managers have an interest in investing in new technologies and workers have an interest in supplying high levels of effort in the utilization of these technologies. Indeed, a critical component of these investments in new technologies is investment in the skills of blue-collar workers. The institution of permanent employment is both cause and effect of this system of skill formation. Armed with substantial skills, moreover, workers can actually participate in not only the utilization but also the development of new technologies [see Fruin 1992].

Male blue-collar workers acquire substantial skills because, like white-collar workers, they undergo a system of cross-training through job rotation during the first ten years of their employment. Recruited from high schools in which they will have received the same high-quality public education as white-collar workers, blue-collar workers have the cognitive foundations for learning a broad array of jobs. The central requirement of these jobs is to eliminate waste while maintaining the flow of work, which in turn requires close monitoring of, and interventions to rectify, variability in the quality of materials and the operation of machines. The cross-training of blue-collar workers is much less demanding than the cross-training of white-collar workers, but nevertheless manifests that, for the company, the blue-collar worker is a valuable asset rather than a dispensable commodity. The multi-skilled capacities of blue-collar workers enable them not only to shift easily from one task or product to another and to be retrained as technology and markets change but also to communicate more easily and effectively with technical specialists in the managerial structure who themselves carry out a considerable amount of their work on the shop floor. The investment in skills throughout the hierarchical structure and the organizational integration of managers and workers creates a system in which problem-solving, and hence learning, are the norms even for blue-collar workers rather than a system, as is typically the American case, in which problem-solving and learning are the exclusive prerogatives of managers.

In effect, the Japanese skill-formation system uses levels of educational attainment to segment the male labor force into managers and workers, but then uses permanent employment, enterprise unions, cross-training, and hierarchical communication to achieve organizational integration both within and between the managerial structure and the shop floor. Included as full-fledged members of this system are males who are regular employees, which includes almost all males employed directly by the major Japanese corporations. As part of the skill-formation process, these corporations also make extensive investment in skills of employees of satellite companies that serve as subcontractors within the enterprise group. "Retired" older workers often take their accumulated skills to these smaller enterprises. In addition, many salaried employees of major corporations forgo the security of their careers with these companies to set up their own subcontracting firms within the enterprise group, thus taking with them to the new firms ten or fifteen years of training that was fully funded by the main company.

Not integrated into the Japanese system of skill formation are most women, many of whom work in major corporations after finishing their formal education but soon drop out of the labor force to bear and raise children. During the late 1980s, however, in the presence of a severe shortage of highly educated labor in Japan and with the help of an Equal Employment Opportunity Law that went into effect in 1986, a large number of university-educated women were hired on permanent-employment tracks and received substantially more company-funded training than had previously been the case. This inclusion of highly educated women into the skill-formation process, however, has proved vulnerable to the recession of the early 1990s, in which, despite substantial company investments in their skills, these women are often finding the promise of permanent employment to be more ephemeral than real [Cannings and Lazonick 1994; New York Times, May 27 1994:5]. The Japanese segment the labor force on the basis of gender, using the skills of women as supplements to the highly integrated, and increasingly formidable, system of skill formation among men.

3. United States

If the Japanese competitive strategy has been to be low-cost producers by eliminating waste in the production process, the American competitive strategy has been to be low-cost producers by eliminating reliance on shop-floor skills. At first sight, therefore, the Japanese system of skill formation, involving as it does heavy investments in shop-floor skills, is in stark contrast to the American process. Indeed, the widely held notions that "Taylorism" and "Fordism" are the characteristic features of American mass-production methods reflect this point of view. To look only at skill formation on the shop-floor, however, misses a key dimension of the skill-formation process in which, throughout most of the twentieth century, the American system has had much in common with that of the Japanese.

Within major U.S. industrial enterprises, substantial skill formation occurs within the management structure. Future managerial personnel are recruited into American companies from universities, although often with more directly relevant (that is, industry-specific) training than in Japan. American companies recruit many university graduates to do research and development in corporate laboratories that maintain close contact with high-level research being carried out in the universities.

Within the enterprise, management development programs rotate lower level technical specialists through the enterprise's various functional departments, product divisions, and geographical locations, thus transforming the most promising specialists into generalists. In most companies, managers have the potential to rise to positions of substantial decision-making power with a select few eventually rising to the top.

Those who do reach the top positions in U.S. industrial corporations need not be substantial owners. A key feature of the managerial revolution that, during the first half of this century, brought American industry to global industrial leadership, was the separation of ownership of company shares from control over company resources [see Lazonick 1992]. Although a market in top managers has emerged in recent years, strategic decision makers in U.S. industrial corporation typically come from

within the managerial structure, their career paths transforming them from technical specialists to managerial generalists as in the Japanese case.

As members of management, these top managers have a basic commitment to invest in the skills of "salaried" employees, who are following similar career paths in the management structure, but not in the skills of "hourly" employees, who are viewed as interchangeable factors of production. The investments in organizationally integrated managerial structures, in which technical specialists are routinely transformed into managerial generalists, has been the foundation of U.S. industrial success in the twentieth century. It is within these managerial structures that are found the technical skills to generate new products and processes and the organizational skills to achieve the high levels of production and distribution required for capturing mass markets.

Where the Japanese system of skill formation most clearly outperforms that of the Americans is on the shop floor. The Japanese invest in shop-floor skills but the Americans do not [Lazonick 1990:chs.9-10]. It is lack of skill on the shop floor, and consequent lack of problem-solving communication between operatives and engineers, that precludes American companies from emulating the Japanese in reducing inventories, defects, downtime, and production-development time.

This despite the fact that, in terms of tenure, American shop-floor workers are only "hourly" in name. High levels of utilization of expensive machinery requires reliable workers, while, since the 1940s, union seniority provisions have provided a high degree of employment security for the most senior workers. Yet the very real divide between management and labor in American companies, institutionalized by the adversarial structure of American unionism and reinforced by the ideology of the hourly worker, has posed a formidable barrier for U.S. industrial enterprises to transform their system of skill formation to respond to the Japanese challenge. As a result, the Japanese have been able to capture large shares of markets where only two or three decades ago both the quality and cost advantages of American corporations seemed invincible. Now in a growing array of industries, it is the Japanese, not the Americans, who are the high-quality, low-cost producers.

4. Germany

The competitive strategy of German industrial enterprises has been to be the high-quality producers in markets that stress product quality rather than product cost. To achieve this objective, German enterprises have focused on the systematic development and utilization of the technical skills of their managers and workers. In Germany, private-sector enterprises play a central role in the system of skill formation but the additional supportive role played by other organizations, particularly in the provision of vocational training for workers, distinguishes the German from the British, American and Japanese systems. Germany has made a substantial national commitment to worker skill formation through the establishment of the most comprehensive and complex system of vocational training in the world. In addition, the Germans have developed a sophisticated network of higher education in engineering and other technical disciplines which, since its institution in the nineteenth century, has continued to serve an indispensable function in the skill-formation process of German managers.

At the heart of this national process of skill formation is the German system of apprenticeship, involving a "dual system" of formal vocational education and on-the-job training. A full apprenticeship in this dual system entails practical training in a company for three or four days per week and attendance at a vocational school (*Berufsschule*) for the remainder of the work week. The practical workplace training provides systematic exposure to the whole range of work situations and problem-solving tasks in a legally defined and regulated occupation. At the end of three years the apprentice is examined on both theoretical and practical competence, and receives his skilled worker's certificate (*Facharbeiterbrief*) [Münch 1982].

Although the initial decisions to invest in this system of skill formation were of national origin, employers and workers, through their respective associations, exert substantial influence on the structure of the apprenticeship system. These associations play roles in setting public training policy at the national and regional (or Lander) levels, and in administering and controlling the operation of the dual system [Münch 1982; Streeck et al. 1987].

The unions argue that employers wield excessive power over the system of skill formation because of their dominance of the regional Chambers of Industry and Commerce that regulate and administer industrial training. Despite this criticism, the detailed legal descriptions of skilled occupations and apprenticeship training plans manifest considerable union influence at the national and sectoral levels. The unions assert that the extensive regulation and standardization of occupations and training protect the interests of workers by giving them access to national labor markets in their skills, thus lessening their dependence on their current employer. The regulation of apprenticeship has occurred despite employers' allegations that it results in rigidity in worker skill formation and their attempts to increase their autonomy in designing training systems more closely aligned with the needs of their particular enterprises. The unions exert only an informal influence on training at the enterprise level, but workers have some say in the implementation of in-firm training programs through the works council (Betriebsrat), the legally mandated institutional mechanism for worker representation at the factory level [Münch 1982; Streeck et al. 1987].

These training structures ensure that the German production worker is highly skilled, thus permitting functions such as maintenance and quality control to be kept to a large extent on the shop floor [Sorge and Warner 1986:124]. The German worker's understanding of the systemic nature of production enhances his capacity for technical problem-solving. In addition, workers are versatile in the tasks that they can perform, and so can be redeployed in response to day-to-day variations in staffing requirements [Maurice et al. 1986:69]. The standard term in German companies for this redeployment capability is *Einsatzbreite*, which is used both formally and informally in evaluating individual workers for promotion [Lawrence 1980:134].

The worker's systemic perspective on production also allows him to understand how best to reap the benefits of new technology, and in some cases his particular skills are put to work to implement the new technology in ways that do not deskill his own tasks [Maurice et al. 1986:70; Sorge and Maurice 1993]. A German worker's skilled status is not inextricably tied to his current job, and German unions are organized on

an industrial rather than a craft basis. Technological change, therefore, does not threaten his conditions of employment to the same extent as it does a British craftsman, for whom the demarcation of his realm of work is a critical foundation of his bargaining power and reward structure. Hence the virtual absence of demarcation disputes in German companies [Lawrence 1980: 134; Sorge and Warner 1986:101, 125; Lane 1989].

The costs of the apprenticeship system are borne in part by governments at the national and Lander levels, in part by employers through voluntary participation, and in part by apprentices themselves in the form of low training wages [Münch 1982; Casey 1986: 65]. One estimate suggests that West German industry made a net annual contribution of DM25 billion to initial vocational training in the 1980s [Financial Times, Aug. 25, 1988]. A relatively low level of worker mobility encourages firms to make this investment in training, but their participation, particularly that of the larger enterprises, is more plausibly explained by their consensus on the importance of worker training to the long term viability of the German economy. As the head of personnel at Volkswagen put it: "Training costs money; not to train costs a great deal more money" [Wall Street Journal, March 18, 1991].

The skill formation of German managers takes place both within and outside of the enterprise. German managers are notable for the high level of formal qualifications that they hold [Lawrence 1980:76]. The vast majority of managers engaged on the technical side of German companies have engineering qualifications. Although less prevalent on the commercial side, engineering nevertheless boasts a stronger showing than any other discipline [Lawrence 1984:80; Lane 1989]. The strong technical training of its managers, together with the close relations that many companies maintain with universities and technical colleges (*Fachhochschulen*, previously known as *Ingenieurschulen*), permit a partnership between science and technology in German companies that has been one of their distinctive sources of competitive advantage since the country's initial industrialization. Their strong technical backgrounds give managers a detailed knowledge of the production process with a particular emphasis on how to build high-quality products.

The formal structures of skill formation on the commercial side of German enterprises have historically been less well developed than those on the technical side. German universities provide courses in business economics (Betriebs-wirtschaftslehre), but this distinctively German approach to business education emphasizes management operational techniques rather than management as a discipline in its own right. German managers have traditionally been highly skeptical that the qualities required in top managers can be effectively taught in the systematic manner used in American business education programs. As a result German post-experience management education programs have placed more emphasis on building relationships among top managers than on academic instruction. Business education is also available through the vocational system in the form of commercial apprenticeships (*kaufmännische Lehre*). Like the study of business economics, however, these apprenticeships have a strong production focus [Lawrence 1980:65; Locke 1984, 1989; Hartmann 1959].

The high level of formal qualifications in German companies does not reflect an exclusive reliance on university campuses as a source of future managerial talent. German companies do recruit for their management structures from universities, in particular favoring those graduates with an engineering degree (Diplom Ingenieur) [Lawrence 1980:76]. These graduates are rarely admitted to senior levels immediately, however, and are expected first to gain experience on the factory floor or in other operational areas [Smyser 1992:70]. Those who are recruited by the company without a university degree can also climb up the company hierarchy, in some cases from the shop floor to the boardroom. At the upper management levels, about one-quarter started their careers as workers [Maurice et al. 1986:118].

To travel this path, an aspiring manager must accumulate formal qualifications in addition to displaying practical capability within the firm. A network of vocational schools facilitates access to the formal education that allows the student to build on his basic apprenticeship training. Before 1970 the standard route to admission to an engineering course, at what was then the *Ingenieurschule*, was a three-and-a-half year apprenticeship [Münch 1982]. The engineering qualification offered by these schools, the Ing Grad, was thus evidence of a student's extensive academic and practical training. The possibility for German engineers to position themselves for managerial careers through apprenticeship and vocational school provides an alternative to the academic route through a university. The Ing Grad degree has proved very popular among German companies, and is particularly common at the middle management level [Lawrence 1980:66; Münch 1982].

The availability of this vocational path to higher education allows German companies to pursue a management recruitment policy that involves substantially more upward mobility from the ranks of workers than is the case in Britain, United States, and Japan. The importance of additional formal education in improving promotion prospects in German companies is manifest in the close relationship between hierarchical position and formal qualification in German industry. As a result, German employees have a clear incentive to invest in their own skill-formation process.

The ability of apprenticed workers to become engineer-managers promotes hierarchical cooperation that has a strong technological foundation. Many engineers, and the *Ing Grad* in particular, hold the *Facharbeiterbrief*, and thus share a common theoretical and practical knowledge base with the skilled worker and the foreman (*Meister*). The organizational integration of technical skills in the managerial and blue-collar structures of German companies leads to a focus on quality in product and process, and many German companies compete on the basis of the excellence of their goods and services [Smyser 1992:68; Streeck 1992:34]. This common commitment of managers and workers to the strategy of producing high-quality products permits decentralization of operational decisions within enterprises.

This decentralization of operational decision-making contrasts with the highly centralized nature of strategic decision making which has historically been a feature of German companies. The planning and allocation of resources is carried out at the apex of German public companies in the framework of a distinctive two-tier board structure which consists of a supervisory board (*Aufsichtsrat*) and an executive board (Vorstand). The close relationship between hierarchical position and formal

educational qualifications in German companies is in evidence among the strategic decision makers on the *Vorstand* and the *Aufsichtsrat, t*he vast majority of whom are graduates in engineering, law and economics [Lawrence 1980].

The Aufsichtsrat is elected by the shareholders, and its consent is required for major strategic decisions such as investments, raising capital, and mergers and acquisitions. Its members are not full-time employees of the company concerned but tend to be representatives of banks, customers, suppliers, major shareholders and top managers from other companies. The Vorstand is the main decision-making body, and its members are professional managers who generally have been promoted up through the company hierarchy [Lawrence 1984:36].

The growing prevalence of the salaried manager in German companies during the past few decades and the increase in the importance of technical skills on the shop floor in building competitive advantage has rendered functional expertise, rather than a more general entrepreneurial capability, increasingly more important as a basis for top managerial authority in German companies. Although functional expertise may not be sufficient for a candidate to be promoted to the ranks of top management, the promotional policies of most German companies mean that functional expertise is a necessary condition to be considered as a candidate for top management in the first place. What constitutes functional expertise in Germany is different than in the United States, where expertise in general management is required to move from middle manager to top manager. In Germany general management is hardly even regarded as a *bona fide* management function [Hartmann 1959; Lawrence 1980:94; Locke 1989:171].

5. Britain

If over the past few decades the Japanese have surpassed the United States as cost leaders in mass markets, and Germany as quality leaders in niche markets, the Americans and the Germans did the same to the British from the last decade of the nineteenth century as the once-dominant British economy ceased to be the workshop of the world. During the last half of the twentieth century, the competitive strategy of British industry has been to survive in a world in which its system of skill formation is decades out of date. Even in the most exclusive of niche markets, such as Rolls Royce and Jaguar cars, where the British had been quality leaders, they have become low-quality, high-cost producers relative to the Germans and now even the Japanese.

At the level of strategic decision making, Britain's problem in the decades after World War II was a failure to separate equity ownership from managerial control in major industrial corporations. Unlike Japan, United States, and Germany, which all experienced thoroughgoing managerial revolutions, the top managers of British enterprises were recruited from either the families of major shareholders or elite educational institutions such as Oxford and Cambridge with a definite bias against technology graduates [see Lazonick 1986].

With the recruitment of top managers through these channels, British companies neglected management development programs that, through job rotation, would transform technical specialists into managerial generalists. Instead, for the more

highly trained employees, British companies relied exclusively on formal education and on-the-job experience, with professional societies such as electrical engineers setting standards independent of business strategy and with technical specialists using interfirm mobility rather than intrafirm rotation as the prime means of acquiring work experience. In comparative perspective, learning in Britain was much more individual than organizational. In the machine-based industries, until quite recently, the more highly trained technical specialists (professional engineers as distinct from operative engineers) continued to be recruited from the shop floor, with on-the-job experience and part-time trade schools providing the means for the professionalization of traditional shop-floor practice.

Even in the 1970s, lower-level technical specialists and middle-level managers in British industrial enterprises were predominantly recruited from the shop floor. Unlike the German system of skill formation, however, in which upward mobility of apprenticed journeymen into the managerial ranks was a form of organizational integration that ensured state-of-the-art levels of product design and performance, the British system of skill formation ensured that traditional practices would remain entrenched, with the strategic managers of British industrial enterprises avoiding the massive investments in a new system of skill formation that could compete with the more advanced systems of Germany, United States, and Japan.

The British shop-floor traditions -- what the trade unions called "custom and practice" -- were the legacies of a skill-formation process in which narrowly defined groups of craft workers trained new workers on the job, and used strict craft demarcations to define their realms of work and their collective bargaining units. It is a system characterized by a high level of fragmentation of the division of labor within plants and with meager corporate investments in the skills of workers. In the absence of a well-developed system of vocational education and enterprise investment in training, such as exists in Germany, British workers had no choice but to hone their skills through on-the-job experience in a narrowly defined craft.

The sharp decline of British manufacturing in the 1980s and the concomitant "Japanization" of British industry have now made Britain's craft system of skill formation an endangered species. But insofar as it exists (and the British themselves have done little to put a new system of skill formation for industry in place), the British system of skill formation is one which, in competition with the Japanese, American, or German systems, can generate neither high quality products nor low unit costs. It is a manifestation of the failure of companies to invest in the skills of their workforces as a basic element of competitive strategy, and the consequent failure to develop organizational structures that can integrate the skills that do exist at the technical or operative levels.

The transformation of skill-formation systems

1. Historical origins and evolution

Why do different advanced industrial nations have different systems of skill formation? This question is not just of historical interest. An analysis of how a structure came into being provides important insights into the elements of continuity, cumulativity, and collectivity that make that structure work, and the potential for transforming that structure when change is required. Specifically, when confronted by a more powerful competitive challenge, how quickly and how effectively can a system of skill formation be restructured?

With a growing recognition of the organizational and technological characteristics of the Japanese challenge, Americans have been asking this question for the past decade or so. More recently, the Germans, as well as other Europeans such as the Swedes, French, and Italians, have begun asking this question as well. Does the possibility of change depend simply on the mind-set of the strategic decision makers in industry? Or does it depend more fundamentally on transforming the relations among participants in the specialized division of labor -- workers, managers, suppliers, and distributors, as well as strategic decision makers? Or does the restructuring of a system of skill formation within industry require the transformation of national institutions such as the systems of education, finance, and law? These are big questions that require big answers. Our purpose here is to provide a historical perspective on the dynamic evolution of systems of skill formation as an intellectual step toward understanding how enterprises, regions, and nations can alter their investment strategies and organizational structures to respond to shifts in competitive advantage.

Our comparative-historical analysis of the evolution of a national system of skill formation begins with the economic development strategy of the nation state and the implications of this strategy for the structure of the national education system. The analysis then focuses on the interests of different social classes -- in particular the managerial class and the working class -- in utilizing, augmenting, or changing the national educational system to pursue their own skill-formation strategies. In comparing the current strategies and structures of skill formation, we began the analysis with the case of Japan because of our contention that it provides the benchmark in generating competitive advantage against which the other nations, United States, Germany, and Britain, must be evaluated. In providing the following historical perspective, we summarize the experiences of these national economies in reverse order, beginning with Britain because of its status as the nation that led the first industrial revolution.

2. Britain

Central to the shift of industrial leadership from Britain to the United States (particularly in consumer goods) and Germany (particularly in capital goods) from the late nineteenth century was a movement from market coordination to managerial coordination of economic activity [Elbaum and Lazonick 1986]. In an era of less

complex technological development, market coordination of economic activity had the competitive advantage of avoiding the higher fixed costs of managerial coordination. But through managerial coordination, the productive benefits that could be attained from more complex technologies justified the high fixed costs -- including the costs of managerial coordination -- of developing and utilizing these technologies [Lazonick 1991:ch.3]

The problem for Britain in the twentieth century was that the very market-coordinated structures of industrial organization that had previously enabled its economy to become the international industrial leader undermined the incentives and constrained the abilities of British enterprises and industries to make the transition to managerial coordination. Without making such an organizational transition, the benefits of the more advanced technologies being developed elsewhere could not be obtained within the British economy.

The origins of the British system of skill formation are found in the ways in which the nation came to experience the world's first industrial revolution. The British mercantilist state played a critical role in fostering the first industrial revolution by using naval power to best the Spanish in the sixteenth century, the Dutch in the seventeenth century, and the French in the eighteenth century in a struggle for world markets. The success of British mercantilism in gaining access to world markets created incentives for the British population to engage in industries that could service these markets. As a result, even before the industrial revolution, Britain had experienced a substantial accumulation of industrial skills even though the British state was not directly involved in investing in these skills [see Wilson 1965; Berg 1985].

Although enterprise management had been important to the success of the pioneering factories in the early stages of the British (or first) industrial revolution, as the nineteenth century progressed, firms came to rely more on the external environment rather than internal planning and coordination to ensure access to the productive resources required to generate (what were by the standards of the time) high quality products at low unit costs. The most important external resource that became available to British manufacturing firms in the nineteenth century was an ample supply of highly skilled and well-disciplined labor. Senior workers -- known collectively as "the aristocracy of labor" -- not only provided their own skills to the building and operation of machinery but also recruited junior workers whom they trained and supervised on the shop floor [Hobsbawm 1984; Burgess 1975; Harrison and Zeitlin 1985; Lazonick 1990: chs.3-6].

Employers' reliance on skilled labor to organize work and train new workers had the advantage of low fixed costs for not only individual firms but also the British economy as a whole. The progress of the British industrial revolution did not rely to any significant extent on state-supported or industry-supported education. The reproduction of an abundant and skilled labor force, effected as it was by worker-run, on-the-job training, required little, if any, expense to either employers or the state [for a case study of a leading sector, see Lazonick 1979].

In the late nineteenth century, moreover, these worker-run apprenticeship systems yielded high levels of labor productivity. Eager to gain entry to the aristocracy of

labor, the promise of promotion kept younger workers hard at work. The older workers, generally protected by union bargains that assured them shares of productivity gains, were themselves not averse to long and steady labor. Skilled workers' intimate practical knowledge of production methods meant that, as by-products of shop-floor experience, they were able to keep imperfect machinery running steadily and contribute to minor technological improvements.

As older workers trained younger workers, supplies of specialized labor expanded in certain localities during the nineteenth century. Given an industrialist's choice of business (itself typically a function of his own specialized training in a particular locality), he would tend to invest where labor with the necessary specialized skills was in relatively abundant supply. As a consequence, particular industries became increasingly concentrated in particular regions of Britain during the nineteenth century. The regional concentration of specific British industries meant that employers had access not only to large supplies of labor with the requisite skills but also to communication and distribution networks that supplied a regional industry with its basic inputs, transferred work-in-progress across the industry's vertically specialized productive activities, and marketed the industry's output.

The growth of a regionally concentrated industry facilitated the vertical specialization of constituent firms in a narrow range of activities, these firms relying on market exchange with other firms to supply them with the necessary inputs and to purchase their outputs for resale downstream. The tendency toward vertical specialization was self-reinforcing because the growing availability of suppliers and buyers for intermediate products made it all the more easy for new firms to set up as specialists. Hence the growth of a regionally concentrated industry was characterized more by the entry of new firms than by the growth of existing firms. Vertically specialized industries became horizontally fragmented industries [for a case study, see Lazonick 1983].

The evolution of industry structures characterized by regional concentration, vertical specialization, and horizontal fragmentation as well as employers' ongoing reliance on skilled labor to organize work on the shop floor diminished the need for business firms to invest in the development of managerial structures. The lack of managerial organization in turn reinforced the tendency for industrial structures to be fragmented and specialized. Limited in their managerial capabilities, proprietary firms tended to confine themselves to single plant operations, thus facilitating the entry of new firms into vertical specialties and, hence, increasing the extent of horizontal as well as vertical fragmentation of industrial sectors. By reducing the managerial as well as financial resources necessary to run a business, the vertically specialized and horizontally fragmented industry structures permitted proprietary capitalists to avoid the separation of capital ownership from managerial control.

The prime source of the development of productive capabilities in the industrial districts of nineteenth-century Britain was the skilled labor required to operate technologies that, even when mechanized, were highly imperfect. With the rise of managerial capitalism abroad in the twentieth century, the persistence of craft-based and market-coordinated industrial structures that had carried the British economy to international dominance in the nineteenth century constituted impediments to the development and utilization of advanced technology. In the staple industries -- iron

and steel, shipbuilding, mechanical engineering, and textiles -- that had brought Britain to economic supremacy, more organizational capability resided in craft control on the shop floor than in the underdeveloped managerial structures [see Lazonick 1990: ch.6]

Insofar as British craft workers continued to cooperate with their employers in the twentieth century, it was in squeezing as much productivity as possible out of the existing technologies, often by failing to maintain the quality of the product and driving their shop-floor assistants as well as themselves to supply more effort. As it became necessary in order to retain their jobs, they also accepted lower wages. Immobile because of their highly specialized skills, both workers and employers had the incentives to ensure the survival of the firms through which they gained their livelihoods. Many British firms in the staple industries were able to survive for decades by living off the plant, equipment, infrastructures, and skills accumulated in the era of British industrial leadership [Elbaum and Lazonick 1986].

In some industries (mechanical engineering in particular), employers tried to use their collective power to break craft control over the organization of work and the determination of remuneration. Even when employers rolled back prior union gains, however, craft control was not eliminated, in large part because proprietary capitalists, lacking managerial structures, had no organizational alternatives with which to replace craft control. What is more, even in a new machine-based industry such as automobile manufacture, in which the craft unions were not already ensconced, shop-floor control on the craft model became dominant in the first decades of the twentieth century as the automobile manufacturers tended to rely on craft workers to plan and coordinate the flow of work on the shop floor [for a summary, see Lazonick 1990:ch.6].

Reliance on shop-floor workers to perform what we now consider to be managerial functions continued during the interwar period, even in firms such as Austin and Morris that were becoming dominant mass producers for the British market [Lewchuk 1987]. In the 1940s and 1950s, under conditions of tight labor markets combined with the limited opportunities for firms that relied on labor-intensive technologies to generate new sources of productivity, these workers used the shop-floor organizational responsibilities that had been delegated to them as the foundations on which to build specialized craft unions. The result was that by the 1960s one could find scores of separate craft agreements in place at any point in time in any one automobile plant, with the resultant fragmentation of employer-employee relations placing severe constraints on the managerial coordination of the specialized division of labor within the plant.

Yet the British automobile industry remained viable in global competition until the 1960s because of its low fixed costs (including the almost complete neglect of research and development) as well as the acceptance of relatively low returns by workers, managers, and owners. The 1960s and 1970s revealed, however, that like the staple industries of the nineteenth century, the British automobile industry had reached the technical and social limits of the utilization of its resources. Facing the continued development of the Continental producers as well as the rise of the Japanese automobile manufacturers, the economic viability of the British industry could no longer be sustained.

The development of organizational capability was somewhat different in the science-based industries of the second industrial revolution -- chemicals, rubber, electrical equipment and appliances -- in which it was impossible to enter into competition on the basis of technological capabilities inherited from the past. Largely through the efforts of dedicated and aggressive entrepreneurs (typically, although not always, owners as well as managers) who either developed new technologies or controlled foreign patents, a number of British firms such as Lever Brothers, Pilkington Brothers, Dunlop, Courtaulds, Crosfield's, Nobel's, and Brunner, Mond, were able to become strong global competitors in the late nineteenth and early twentieth centuries [for business histories, see Wilson 1984; Barker 1977; Jones 1984; Coleman 1969; Musson 1965; Reader 1975].

Nevertheless, after the turn of the century the largest British firms were not only much smaller than the largest U.S. companies, but also much more under the control of family ownership. Our explanation for the persistence of "personal capitalism" lies in three interrelated systemic dimensions of the social environment in which the nation's industrial enterprises operated: the social system, the educational system, and the financial system [see Lazonick 1994a].

British industrialists of the late nineteenth century were generally middle class, with their home bases in the industrial districts of the Midlands and the North. Among those engaged in business, large accumulations of wealth and substantial political power were in the hands, not of these industrialists, but of financiers based in the City of London. Using upper-class educational institutions as means of entry and marriages as instruments of merger, wealthy financiers joined with the old landowning elite (many of them grown recently wealthy through rising land values) to form a new aristocracy. The wealth of this restructured upper class was not, as was increasingly the case in the United States and Germany, based on the application of science to industry and the resultant profits from technological innovation. Rather the bases of wealth in financial activities were social connections and acquired reputations. Hence the importance for ultimate economic success of family connections and associations made at elite educational institutions -- Oxford and Cambridge as well as public schools such as Eton and Harrow [for elaboration of these arguments, see Lazonick 1986].

Lacking industrial roots, the aristocracy who controlled these elite institutions during the era of the second industrial revolution had no need for an educational system that developed technologists. They valued the study of science as a branch of sophisticated knowledge, but had no interest in its application to industry. Indeed, the British elite positively resisted the notion that a concern with technology had any place in an aristocratic education. They wanted education to set them apart from the lower orders, not bring them in closer contact with them. For, as we have already outlined, in the rise of Britain to international industrial dominance during the first industrial revolution, technological knowledge had generally been in the possession of groups of workers -- the so-called "labour aristocrats" -- who gained this knowledge through the development and utilization of machinery on the shop floor.

Nor did successful industrialists who accumulated sufficient fortunes to contemplate joining Britain's upper class effectively challenge the anti-industry bias of Britain's elite educational system. Of middle-class, or even working-class, backgrounds,

Britain's most successful industrialists sought to elevate their social standing by distancing themselves from the technological roots of their prior advance. They typically located their head offices in London, distant from industrial production. They sent their sons to be educated at the elite public schools and, if possible, at Oxbridge, to network with an aristcracy that was anti-technology. Hence these industrialists, and particularly the most successful among them, did not see it as in their interests to transform the nation's premier educational institutions into servants of industry. Their goal was rather to partake of aristocratic culture to serve their aspirations for upward mobility, which meant accepting the anti-technology bias of that culture. As the historian Donald Coleman [1973] has put it in a well-known essay, successful industrialists sought to become "gentlemen" rather than "players".

In seeking to move up the social hierarchy, successful industrialists did not abandon industry for finance; barriers to entry into finance and related pursuits were high precisely because of the centrality of social connections and reputations to the success of the financial enterprise. Rather, as successful British industrialists sought to move up the social hierarchy, control over established industrial enterprises remained the foundations of their material wealth and the most assured means of passing wealth on to their children. They brought their sons and sons-in-law in to manage their businesses, thus perpetuating the integration of family ownership and control. The larger owner-controlled firms that, because of enterprise expansion or a dearth of qualified family members, had to recruit top managers from outside the family gave highest preference to young men with a classical Oxbridge education. As a result, the most influential British industrialists put little pressure on the elite educational institutions to offer technical and organizational training even to the future captains of industry [see Lazonick 1986; 1991:ch.1; 1994].

By virtue of their educational backgrounds and social aspirations, those in control of British industrial enterprises in the first half of the twentieth century were not themselves well-equipped or well-positioned to lead their companies in the pursuit of technological innovation. Within the enterprise, top managers of the most successful enterprises of the second industrial revolution set themselves apart as an elite social class, thus creating an organizational barrier between themselves as strategic decision makers and the technical specialists who were expected to implement enterprise strategies. Increasingly after the turn of the century, many of the technical specialists employed by science-based enterprises came from the newly established provincial universities that did try to cater to the educational needs of technologists. The second-class status of the graduates of the provincial universities was confirmed when they took up employment in a major British industrial enterprise. Because of the way the top managers of the personally managed enterprises were recruited, these technical specialists could not view their initial employment in even the larger enterprises as a first step up a managerial hierarchy that might ultimately lead to a position of control.

As a result of these barriers to social mobility within the enterprise, technical specialists were less committed than they might otherwise have been to furthering enterprise goals, and more likely to view interfirm mobility as the main route to career progress. Such prospects of employee exit in turn reduced the incentive for the top managers of these enterprises to invest in the productive capabilities of these technical specialists. Even in the cases of trained scientists and engineers, therefore,

leading British enterprises relied more on market coordination than management coordination in their employment of labor [see Dore 1990]. In industries in which the development and utilization of technology depended on the development and utilization of highly specialized technical skills, enterprises that relied on market-coordinated employment relations could find themselves at a decided disadvantage in global competition.

3. Germany

The foundation for Germany's world renown in the field of academic technical education was laid in the early part of the nineteenth century. At this time German universities were probably as averse as their British counterparts to the establishment of links with industry and commerce. Noble birth had been replaced as the exclusive standard of social prestige by formal Bildung (*culture*), to be acquired through a classical education [Locke 1989:62; see also Veblen 1968:78].

State-building ambitions, particularly those of Prussia in the wake of its ignominious defeat by Napoleon, provided the initial incentive for the promotion of technical education. Specifically, in its attempts to foster economic growth, the Prussian bureaucracy identified a need for specialized occupational instruction to be provided outside the orbit of general education. Beginning in 1821 with the Technical Institute in Berlin, the official in charge of technical education, Peter Beuth, laid the basis for the marriage between science and industry when he founded a number of technical institutes (originally Polytechnische Schulen, renamed as *technische Hochschulen*) and a network of trade schools in the provinces [Gispen 1989; Konig 1993:68].

Engineering was not regarded as a legitimate academic field at this stage, and engineers were generally restricted from the higher ranks of the civil service. As a result, the teachers at these technical schools were accorded a lower status than university professors, a status which they endeavored to elevate by incorporating more theory into their subject and by adopting the university tradition of *Wissenschaft* (science) in their research. They succeeded in creating a third science, *Technik*, a unique combination of scientific knowledge and craftsmanship. In 1900 the *technische Hochschulen* became the first in the world to award engineering doctorates [Locke 1984:40; Konig 1993].

Many engineers were opposed to these developments and called for less academic engineering education that was less academic. They contended that an overemphasis on theoretical knowledge in the education of engineers was undermining German industrial performance, particularly in industries such as light machinery in which Americans held the advantage through mass production based on interchangeable parts [Gispen 1989]. In the 1890s the German government introduced a new type of nonacademic engineering education which was consciously modeled on the practical skills and shop training of American engineers (even as "shop culture" was making way for "school culture" in the United States [Gispen 1990:105; Calvert 1967]. The new schools, the *Ingenieurschule*, were designed to supplement the existing system of higher technical institutes. The setting up of mechanical laboratories at the longer established schools also allowed them to become more integrated into industrial activity [Konig 1993:78].

A bitter battle over professional status broke out among German engineers around the turn of the century. This conflict between an academic group and a more practice-oriented faction ultimately led to the concentration of power in the engineering profession in the hands of a third group - the managerial and entrepreneurial engineers, who had an interest in integrating theory and practice and who had the ability to cement the links between German industry and technical education [Gispen 1989].

The resultant relations between German industry and German institutes of higher education were critical for the nation's industrial development. In contributing to national industrial performance, it is not the formal educational system per se that is important (as the British case shows), but how the knowledge and skills that it generates are integrated into industrial activity. In the industrialization of Germany, the marriage of technical knowledge and industrial activity became the foundation for the nation's competitive advantage in chemicals, metals, electrical machinery, and heavy general machinery.

Besides supporting industry's efforts to restructure education for technical skill formation, the German state also played a significant role in stimulating an industrial demand for these skills. The establishment of the Zollverein in 1834 transformed a collection of diverse local markets into one integrated German market. The State's program of economic unification, and subsequently Bismarck's "blood and iron" campaign for political unification, provided the requisite stimuli for investment in the expansion of a railroad network and in the construction of a transportation and communication infrastructure more generally [Henderson 1967:191]. The resultant physical integration of the German states allowed entrepreneurs to reap the economies of scale and scope they needed to justify their substantial investments in physical and human capital [Chandler 1990:411].

The development of the German infrastructure created an unprecedented demand for technical knowledge. Engineers were recruited in droves not only by those immediately involved in infrastructural construction, such as the railroad companies and the electrical equipment manufacturers, but also by supplier industries like metals and machine-building. Indeed, nearly all of the German heavy machinery enterprises initially expanded to satisfy the demands of railroads, shipbuilders, iron producers, and mining companies [Chandler 1990:457]. The State was also an important customer for sectors such as steel, chemicals and shipbuilding, as it built its vast military machine before and after 1870.

Advances in technical knowledge sometimes created new investment opportunities, with the organic chemicals industry as the clearest example of such a phenomenon. The researchers in the laboratories of German chemical companies, universities, and technical institutes were so central to the development of the chemicals industry that it could be claimed that technical knowledge had founded an entire industry [Henderson 1975:186].

Regardless of what forces prompted the initial marriage of science and industry -- an industrial opportunity, technical knowledge, or a combination of the two -- the mixture proved to be a potent one. As it increasingly generated opportunities for

growth, the initial integration of technical skills evolved into a powerful basis for greater skill formation in the managerial structures of individual enterprises.

In the electrical industry, engineers focused on minimizing costs and ensuring product safety in their attempts to compete with well-established alternative energy and lighting systems in the 1860s and 1870s. They achieved these objectives through standardization that permitted the use of interchangeable parts to drive down costs, and allowed the electrical companies to maintain high standards of product quality [Brady 1933:180]. The manufacturing and design discipline that the electrical engineers developed during this process diffused through the German economy because of the electrical industry's technological linkages with many other sectors [Brady 1933:185].

In the German machine industry, such patterns of concentration and standardization were less prevalent. Few companies could compete in light machinery with the Americans who had built a competitive advantage using mass-production methods based on interchangeable parts and high throughput to drive down unit costs. The markets that the Germans served gave them a different production philosophy. They focused on heavy machinery that was generally built to customer specifications, often those of the government. Their competitive advantage, therefore, depended on their ability to acquire and develop technical skills in functional design and precision manufacturing [Kocka 1980:104, Chandler 1990:457].

Despite differences across sectors, many German companies came to rely on technical knowledge to achieve quality in design and manufacturing and to compete in markets where such an emphasis could form the basis for a sustainable competitive advantage. In the first few years of the century, the balance of German exports shifted from textiles and consumer goods to these technically-based industries [Chandler 1990:410].

The institutional development of German business education mirrored that of technical education. The first German schools for business education, the commercial schools (*Handelhochschulen),* were set up outside the university system, as the technical institutes had been [Locke 1989:88]. The commercial schools, however, received less state support than their technical counterparts. Moreover, German industrialists were skeptical about the value of this type of business education so the close links between industry and academia that distinguished German technical education did not develop on the commercial side [Locke 1984; Kocka 1980:97]. The situation changed to some extent following the rationalization of German industry after World War I that stimulated a need for commercial training. In responding to this demand, German business educators developed their own distinctive field of operations-focused accounting, which they called business economics (*Betriebswirtschaftslehre*) [Locke 1984].

The more important scientific technology became for the activities of the business enterprise, the more likely it was that technically trained recruits would take over managerial functions [Kocka 1980:95]. By 1900 many German companies had built substantial hierarchies of salaried managers, a large number of whom were engineers. Some of these managers had even advanced to the supervisory boards of these companies to participate in strategic decision making. Managerial hierarchies

were more common in Germany than in Britain at this time, but family control remained more pervasive in German enterprises than in American ones [Chandler 1990:500]. In many well-known German cases, original entrepreneurs and their family members who retained control of managerial hierarchies were talented engineers in their own right.

The role of the large German banks (*Grossbanken*) in financing the initial development of the capital-intensive industries and in fostering the process of industrial concentration that began in the 1870s has been well-documented. The financing role of the Grossbanken diminished after 1900 as the companies that they served built up enough retained earnings to finance their own development [Kocka 1980:92; Chandler 1990:419]. Yet these banks maintained substantial shareholdings in these companies, either directly through ownership positions or indirectly through the exercise of the proxy rights attaching to shares deposited with them (Depotstimmrecht). Representatives of the Grossbanken generally sat on the supervisory boards of the companies that they had financed. Through their exercise of the prerogatives of ownership, the banks continued to play a central financial role by ensuring company earnings were retained for further investment rather than withdrawn for dispersal to wealthy individuals.

In first financing and then ensuring the sustained growth of German enterprises, the Grossbanken developed strategic decision-making capability. Before a Grossbank was willing to invest in a business, it generally evaluated the condition and performance of that enterprise. As early as the 1890s, the banks set up trustee (*Treuhand*) societies to perform this task. These organizations recruited auditors who were trained in industrial and financial accounting and developed techniques for analyzing the industrial operations of bank clients. These in-house skills allowed banks not only to understand the organizational and technological requirements of their investments in industry but also to serve as informed and useful advisors to many industrial companies. Indeed, in the first decades of the twentieth century these societies built an independent business as general consultants to German enterprises on the basis of the skills that they had formed in analyzing the operations of the banks' clients [Locke 1989:232]

In the course of its industrialization, the industries in which Germany acquired international competitive advantage were more dependent on a distinctive national system of managerial than shop-floor skill formation. In some of these industries, such as chemicals, shop-floor workers were required to have very few skills. In industries that did require shop-floor skills, such as the electrical and heavy machinery sectors, employers controlled the process of skill formation for their workers during this period in a similar manner to their American competitors.

It was only as the century unfolded that the Germans developed a unique process of shop-floor skill formation at the national level. The skills that this process developed were organizationally integrated with managerial skills after World War II to form the basis for German competitive advantage in markets where quality in product and in process were critical, such as luxury cars, precision machine tools, and optical equipment [Vogl 1973].

The system of skill formation for shop-floor workers depended critically on the transformation of the formal educational structure, and specifically the vocational training system. As in the case of the managerial skill formation process, the Prussian and later the German state and the social structure played influential roles in this development.

The German apprenticeship system has its roots in the guild system of craft apprenticeship in the Middle Ages. By the middle of the nineteenth century the forces of economic liberalism had severely undermined the old corporate order. Moreover, the repression by the Prussian state of journeyman organizations severely weakened these institutions. Thus, there was considerably less continuity in Germany than in Britain between the traditional craft-based organizations of the Handwerk sector and the trade union movement despite the fact that journeymen were its mainstay in its early years [Kocka 1986:291]. By the end of the nineteenth century the German labor movement was more class conscious and less craft conscious than its British counterpart [Kocka 1986; Nolan 1986].

The trend away from craft-specific identification toward a more class-based one became more marked as the century drew to a close because of the nature of the industrialization process in Germany. In many of the new industries of the second industrial revolution that formed the core of German industrial dynamism, the novelty and technical complexity of their processes meant that existing craft skills could not take root on the shop floor with the same alacrity as had been the case in industries like textiles during the first industrial revolution.

In attempting to raise their living standards, German workers, unlike the British, relied more on their strength as a mass political movement than on the importance of their craft skills in production. British unions tended to exert their influence at the level of the individual plant or enterprise and to adopt restrictive practices and block innovation to protect their crafts. Such practices were far less prevalent on the German shop floor [Kocka 1986:342]. German unions relied mainly on membership recruitment and strikes to win wage concessions from individual employers [Kendall 1975:96; Braunthal 1978:21; Nolan 1986:381].

In the early years of the new century the labor movement was confronted by the powerful industrialists who had emerged from the process of industrial concentration in the form of a unitary Federation of German Employers (Vereinigung der Deutschen Arbeitgeberverbande: VDA). This organization was opposed to unions, and did everything in its power to defeat organized labor [Kendall 1975:97; Nolan 1986:392]. The need to negotiate with the highly organized employers led the unions to adopt centralized structures themselves [Braunthal 1978:21]. The unions registered some gains in the negotiation of agreements with employers at the national and regional levels. In the prewar years, however, employers controlled the workplace and dominated the process of shop-floor skill formation [Kendall 1975:98].

The apprenticeship system in Handwerk supplied many workers to the burgeoning industrial sector but it was not specifically designed to serve the needs of industry [Sorge and Warner 1986:185]. Thus, many of the larger employers had invested in their own facilities and programs that modified and supplemented the traditional

training structures at the level of the individual enterprise. In the early decades of the twentieth century virtually all large factories had their own apprentice school in which workers were trained [Brady 1933:44, 187]. Concerned that this type of vocational training would tie workers to individual companies and reduce the power of the mass labor movement, the response of the unions was to push for training systems that were standardized and regulated at the national or industrial level [Sorge and Warner 1986:185].

The survival of the traditional apprenticeship structures depended on the economic viability of the Mittelstand, the small- and medium-sized enterprises that characterized much of the German industrial economy. The Bismarck government had a clear political interest in bolstering the position of this group as a buffer against the rise of the socialist movement [Streeck 1992:112]. After the 1870s, however, when modern industrial companies increasingly entered the traditional markets of small artisans, the demise of traditional apprenticeship seemed imminent. The German Reich introduced new legislation in 1897, 1900 and 1908 in an attempt to secure the economic position of the *Handwerk* sector in this climate of rapid industrialization. These acts established the basis of obligatory guilds, restored their corporation rights, and introduced the "limited certificate of competence" requirement for the training of apprentices [Münch 1982; McKitrick 1994:ch.6].

Although the Weimar constitution left the prewar social structure intact, working class demands were accorded more consideration at least in the early years of the Republic. The Weimar period saw the continuation of the trend in union-employer relations toward the consolidation of the power of the unions at the national and regional levels rather than at the level of the individual enterprise or plant [Braunthal 1978:87]. In an attempt to ensure that their influence had as great an impact as possible, and to restrict the autonomy of individual employers, the unions attempted to formalize many elements of the employment contract [Braunthal 1978:153]. In 1925 the unions introduced occupational profiles and training plans for a variety of apprenticeships. The training structures in handicraft, industry, and services, however, remained independent [Sorge and Warner 1986:185].

That the unions were more concerned with building the political basis for their power than with preserving skills on the shop floor (as the British unions sought to do) became particularly apparent in the Weimar period. Since the power of labor had been institutionalized to a considerable extent in the Weimar Republic, the unions were confident of their ability to gain a fair share of the national wealth and were willing to promote measures to build the competitive strength of German industry. Thus, following a period of initial indifference to scientific management, the German Free Unions accorded it their wholesale support in the 1920s [Guillén 1994:109].

The introduction of collective bargaining and the increased regulation of the employment contract during the Weimar period restricted the power of the employers to a certain degree. At the shop-floor level in 1920, moreover, the establishment of works councils (Betriebsrate) in plants with more than 50 employees represented an explicit attempt to give workers a voice in plant operations. The process of rationalization and concentration of industrial activity that took place during the Weimar years, however, strengthened the power of industrialists and weakened that of workers and their unions. As employers regained their prewar strength they

became more resistant to the demands of the workers [Braunthal 1978:175; Nolan 1986:392].

During the Weimar period it became apparent that the *Kaiserreich's* legal protection of the *Handwerk sector* had not ensured its economic viability. Throughout the 1920s the *Handwerker* felt threatened by dynamic industrial enterprise on the one hand and the socialism of the working classes on the other. They channeled their fears and frustrations into politics, and ultimately into support of the National Socialists. During the Nazi period the authoritarian hand of the State intervened once more to shape the skill formation process. Under the Nazi regime, the *Handwerk* sector was integrated into the German industrial economy in the interests of raising the productive capabilities of the wartime economy, the training system was standardized and regulated, and thus the foundation for the modern German system of apprenticeship was laid [McKitrick 1994].

With the establishment of the Federal Republic of Germany after World War II, an institutionalized and highly regulated system of industrial relations emerged. A dual system of worker representation was set up in German industry with responsibility and authority divided between industrial trade unions and institutions of codetermination. In this system the unions exert a significant influence at the industrial and regional levels through the process of collective bargaining whereas at the level of the individual enterprise their control is only informal. At the enterprise level, however, workers' representation on supervisory boards and, to a more widespread extent, on the works councils gives workers a legal voice in company operations.

This dual system of representation also applies to the system of worker training. After World War II the government of the Federal Republic of Germany retained training structures in much the same way that the Nazis had shaped them. The regulation and administration of apprenticeship training changed, however, to reflect the new social order. Trade unions were included on the vocational training committees of chambers, and became involved with government ministries and employers' associations in the joint regulation which takes place in the top decision-making bodies of the overall training system. At the level of the enterprise, the works councils have the right to negotiate with the individual employer about the structure of the in-firm training program and are involved in its implementation in the workplace.

Despite criticisms of the training system, many German companies have successfully integrated the blue-collar skills which it has developed with the technical skills of managers to build the postbellum success of West German industry [Münch 1982; Financial Times, June 3, 1991]. The establishment of the German system of apprenticeship, with its inclusion of the unions and the government as strategic decision makers in the worker training process, reduced the autonomy that employers had in setting a strategy and structure of worker skill formation to suit the needs of their particular enterprises. The apprenticeship system, however, allowed employers to reap the benefits of the organizational learning of a collective training process that is explicitly designed to integrate the demands of a variety of industries in its structure. In certain industries and competitive environments, this tradeoff has been highly attractive to employers. In historically stable technology industries, high-

quality worker skills can compensate for a loss in enterprise flexibility. In industries that involve high levels of innovation, and thus place a premium on enterprise flexibility, the tradeoff may not be as attractive.

Worker skills have played a pivotal role in the competitive strategies of those large West German companies that compete on the basis of quality in product and process, and have allowed them to build a competitive advantage in markets such as luxury automobiles, precision machine tools, and electrical machinery which qualified as stable technology until quite recently. Although some successful German companies have emerged in innovative and high technology sectors such as computers, semiconductors, and telecommunications, Germany has not secured national competitive advantage in these industries [Katzenstein 1989:25].

The same training system has also provided the foundation for the competitive advantage of many of the small- and medium-sized enterprises that constitute the German Mittelstand. Before unification, companies that employ less than 500 employees represented approximately 50 percent of West Germany's GDP and two-thirds of its workforce. Mittelstand companies are responsible for the training of most of Germany's apprentices [The Economist Survey: West Germany, Oct. 28, 1989]. Many of these small- and medium-sized enterprises have developed strong positions in high-quality niche markets such as precision machine tools and laser optics through the excellence in product design and production flexibility that their workers' and managers' technical skills permit [Herrigel 1989:191; Smyser 1992:68].

4. United States

Like Germany, but unlike Britain, the United States went through a managerial revolution from the last decades of the nineteenth century [Chandler 1990]. The emergence of a transcontinental market, linked by a transcontinental communications system and populated by millions of independent farmers and artisans, created vast market opportunities for enterprises that planned and coordinated the processes of production and distribution. To do this planning and coordinating, entrepreneurs had to build teams of committed managers, and, particularly in the more capital-intensive industries, those enterprises that built the most committed and skilled managerial teams were able to capture huge market shares [Chandler 1977].

In the emergence of American managerial capitalism, the state played a major role in subsidizing the communication system, with a particular emphasis on railroads, and in erecting national tariffs. Until the last decade of the nineteenth century, however, a formal system of higher education was relatively unimportant for the preparation of managerial personnel, in part because American industry was only beginning to make the transition from the machine-based first industrial revolution, in which shop-floor experience remained important, to the science-based second industrial revolution, in which systematic formal education was a necessity. Hence the earlier integration of higher education into the industrial economy in Germany, where state efforts to build the nation's military strength stimulated growth in the new science-based industries as well as the scientific transformation of certain sectors of the traditional of the machine-based industries.

As Alfred Chandler [1977] has shown, important early schools for late nineteenth-century managers were the transcontinental railroads that were themselves central to creating the national market. Indeed, many technical specialists and managers acquired their experience by moving from one industry to a technologically related one [Hounshell 1984; Thomson 1989]. From the late nineteenth century, however, the system of higher education became central to supplying technical and managerial personnel to the burgeoning managerial bureaucracies of America's industrial corporations. In Britain, as we have seen, the higher education that positioned men for top management positions served to distance these future leaders from the application of science to industry rather than immerse them in it. A classical college education, modeled on Oxbridge, had in the mid-nineteenth century also held sway in the United States at institutions of higher learning such as Harvard and Yale. With the coming of managerial capitalism, however, these educational institutions were transformed to meet the requirements of U.S. industrial enterprises for line and staff specialists.

The pressure for educational change began to build in the mid-nineteenth century when the advocates of Jeffersonian democracy sought to establish institutions of higher learning that would elevate the social standing of the independent farmer and artisan while providing them with advanced practical knowledge in agriculture and the mechanical arts. The ultimate legislative result of this movement was the Morrill Land Grant College Act of 1862 that provided funding for the establishment of agricultural and mechanical arts colleges in every state in the nation. As it turned out, however, individuals intent on being independent farmers or artisans had little use for the bachelor's degrees that the land-grant colleges offered.

But the emerging system of managerial capitalism did. In current discussions of the rise of U.S. managerial capitalism, a much neglected industry is agriculture. From the 1890s the U.S. Department of Agriculture in effect transformed the land-grant colleges into operating divisions of a huge managerial bureaucracy. In regional experiment stations attuned to improving productivity of local crops, these bureaucrats applied science to industry. Through extension services, they sought to diffuse the resultant technologies to the mass of farmers who, in their combined roles as "plant" managers and "shop-floor" workers, transformed purchased inputs into salable outputs [Ferleger and Lazonick 1993]. Also from the 1890s, U.S. manufacturing enterprises began to take an interest in the land-grant colleges -- MIT among them -- as a source of supply of scientists and engineers [Noble 1977; see also Servos 1980]. For this was a time when, for the sake of developing new technologies, the most prominent U.S. mass-production enterprises were building in-house capabilities to apply science to industry [Reich 1985; Hounshell and Smith 1988; Mowery and Rosenberg 1989:Part II], and for the sake of utilizing these new technologies, were successfully eliminating craft control of production from the shop floor [Montgomery 1987; Lazonick 1990:ch.7].

The growing importance of the land-grant colleges in American economic life in turn put pressure on the classical colleges to make their scientific and educational activities relevant to the needs of industry. Especially after the turn of the century, when (largely through philanthropic foundations established by business fortunes) wealth accumulated in industry provided massive funding for education, managerial

capitalism could make use of the entire system of U.S. higher education, whether privately or publicly funded. Industrial enterprises increasingly recruited managerial personnel from the system of higher education, and then, through in-house training and on-the-job experience, developed the productive capabilities of these employees and promoted the best of them to middle-level and upper-level managerial positions.

That there was room at the top for such career managers had been ensured by the separation of asset ownership from managerial control over the utilization of these assets and the returns that they generated [Lazonick 1986]. As late as the 1890s in the United States, ownership of industrial enterprises had been integrated with managerial control. Yet over the next generation, a separation of ownership from control occurred in the most successful and enduring U.S. managerial enterprises. Until the Great Merger Movement that began in the 1890s, a national market in industrial securities did not exist in the United States [Navin and Sears 1955]. By the 1890s, however, a number of enterprises in the more capital-intensive industries had used retained earnings to finance continuous innovation that enabled them to capture dominant market shares. Key to the success of these enterprises was the willingness of owner-entrepreneurs to invest not only in production and distribution facilities but also in managerial personnel. These dominant enterprises were central actors in the Great Merger Movement, and the most successful mergers occurred in the industries of the second industrial revolution -- industries in which enterprises gained competitive advantage through continuous product and process innovation and high-speed utilization of production and distribution facilities [Chandler 1990:ch.3]

The Great Merger Movement did more than merely concentrate industry. With J. P. Morgan taking the lead, Wall Street financed the mergers by selling to the wealthholding public the ownership stakes of the entrepreneurs whose companies were being merged. The ultimate result was the creation of a national market in industrial securities. Through the mediation of Wall Street, ownership of the assets of the newly merged companies were transferred from the original owner-entrepreneurs to a widely distributed population of wealthholding households. After the turn of the century, a company that emerged as dominant in its industry could go public without merger, and have its shares listed on the New York Stock Exchange.

In taking these enterprises public, the sale of common shares did not finance new investments in organization and technology. Rather it financed the retirement of the old owners from the industrial scene. In purchasing these shares (increasingly on the secondary market), the new owners did not assume managerial control. What attracted these portfolio investors to the stock market was the fact that an ownership position in a company did not require any further commitments of time, effort, or finance to that company. When owners became dissatisfied with the performance of "their" companies, they could simply sell their ownership stakes on the highly liquid stock market to other, anonymous portfolio investors who wanted to become owners for awhile. Ownership had been separated from control [see Lazonick 1992].

The managers now in control were not owners but salaried employees. Increasingly in the first decades of this century, the salaried employees who rose to positions of top management in U.S. science-based enterprises had been recruited to their companies as university graduates in search of careers. The education that they received, moreover, provided them with the basic cognitive capabilities to apply

science to industry -- capabilities which they improved through in-house training and experience during the course of their careers [Lazonick 1986].

Besides permitting the separation of ownership from control, the rise of managerial coordination in the United States had profound implications for the organization of work on the shop floor. Unlike Britain with its accumulations of skilled labor supplies in industrial districts, the interregional and interoccupational mobility of workers in the United States rendered skilled labor scarce throughout the nineteenth century. The alternative opportunities for self-employment as farmers and artisans available in the United States made skilled wage labor not only expensive for difficult to discipline. Even in the early Lowell textile industry, when U.S. industrialists wanted to engage in mass production, they had to look to skill-displacing technological change to overcome the constraints on labor supply that a highly mobile workforce imposed. To ensure the development and utilization of the skill-displacing technologies, U.S. industrialists had to invest in managerial structures. The result was the rise of a characteristic "American system of manufactures" by the middle of the nineteenth century [Hounshell 1984; see also Lazonick and Brush 1985].

Nevertheless, during the rapid postbellum expansion of American industry, U.S, manufacturing enterprises, and particularly those that sought to compete on growing national markets, found that they had to rely extensively on skilled labor to coordinate, and even in many cases plan, production activities. By comparison with the persistence of craft control in Britain, however, American reliance on skilled shop-floor labor to coordinate production activities was generally short-lived, as U.S. industrialists developed technological and organizational alternatives to leaving skills, and the control of work, on the shop floor. By employing unskilled immigrants from eastern and southern Europe, by investing in deskilling technological change, and by elaborating their managerial structures to plan and coordinate the productive transformation, U.S. industrial capitalists attacked the craft control that workers -- typically of British and German origin -- had staked out during the 1870s and 1880s [Montgomery 1987].

The initial response of shop-floor workers to the exercise of managerial control was to form craft unions. When employers refused to bargain with these unions, shop-floor workers turned to the restriction of output to exercise direct control over the relation between the work effort they provided and the pay they received. During the first three decades of this century, employers used both political and economic power to undermine workers' attempts to assert shop-floor control. They relied on repression, instigated and financed both privately and publicly, to eliminate radical elements in the American labor movement. But having deprived their workers of militant alternatives, leading industrial employers also gained the cooperation of their shop-floor workers by sharing some of the managerial surplus with them and by holding out (what during the 1920s at least appeared to be) plausible promises of employment security [see Brody 1980].

The phenomenal productivity growth that U.S. manufacturing experienced in the 1920s could not have been achieved without managerial success in gaining control over work organization on the shop floor. At the same time, however, the decades-long managerial offensive against craft control, combined with the evolution of a

highly stratified educational system that effectively separated out future managers from future workers even before they entered the workplace, left a deep social gulf between managers and workers within U.S. industrial enterprises. During the 1920s, even as many dominant industrial enterprises shared some of their surpluses with workers in the forms of higher wages and more employment security, U.S. managers, ever fearful of a reassertion of craft control, continued with their quest to take, and keep, skills off the shop floor [Lazonick 1990:ch.7].

The Great Depression, with its massive layoffs of blue-collar workers even by many of the most progressive employers of the 1920s, served to deepen the social separation of management from the shop-floor labor force. In response, the U.S. labor movement reorganized, but this time on an industrial rather than a craft basis, and used the crisis of the 1930s to wring from the state a measure of economic security for workers that private enterprise had shown itself incapable of providing. When, in the renewed prosperity of the 1940s, dominant mass producers once again sought to gain the cooperation of workers by offering them high wages and prospects of secure employment, they had to deal with powerful mass-production unions.

These unions did not challenge the principle of management's right to plan and coordinate the shop-floor division of labor [see Lazonick 1990:ch.9]. In practice, however, the quid pro quo for union cooperation was that seniority be a prime criterion for promotion along well-defined lines, and ever more elaborate job structures, thus giving older workers best access to a hierarchical succession of jobs paying gradually rising hourly wage rates. In return, union leadership sought to ensure orderly collective bargaining, including the suppression of unauthorized work stoppages.

From the 1940s to the mid-1960s, union-management cooperation in the coordination of shop-floor relations permitted high enough levels of productivity to sustain competitive advantage, despite the failure of the dominant mass producers to address the issue of deskilled, monotonous, and hence alienating work. By sharing with blue-collar workers some of the gains that came with international dominance, U.S. mass producers exercised a substantial degree of control over the supply of effort on the shop floor. But, just as the structures of cooperative labor-management relations that served British employers well in the nineteenth century were to become barriers to organizational transformation in the twentieth, so too would the labor-management relations that prevailed in the U.S. era of economic dominance prove problematic when a more powerful mode of developing and utilizing technology came on the scene.

5. Japan

Over the past two decades, Japanese manufacturing has outperformed U.S. manufacturing in the mass production of consumer durables, particularly automobiles and electronic equipment. These are the industries in which U.S. industry had its greatest international competitive advantages in the first six decades of this century. Having gained competitive advantage in the consumer-durable industries, Japanese manufacturing has also made great progress in vertically-related capital-goods industries: machine tools, electrical machinery, and semiconductors.

Entering the 1990s, there is no doubt that Japanese manufacturing has taken the leading role in the microelectronics-based third industrial revolution.

As was the case historically in the United States and Germany, the Japanese state has played an important role in protecting the home market to permit business organizations to develop and utilize their productive resources to the point where they could attain competitive advantage in open international competition. But the Japanese state has also gone further. It has maintained a stable macroeconomic environment, including high levels of employment and a relatively equal distribution of income across sectors, thus enlarging the extent of the Japanese market for manufactured goods. It has created incentives for consumers and businesses to purchase goods (for example, televisions and computers) that embody state-of-the-art technologies. It has limited the number of firms competing in major manufacturing industries, thus creating incentives for these firms to incur the high fixed costs necessary to attain competitive advantage. It has promoted cooperative research and development among major Japanese competitors. It has ensured manufacturing corporations access to inexpensive finance. And the Japanese state has provided industry with a highly educated labor force to fill blue-collar, white-collar, and managerial positions [Johnson 1982; McCraw 1986; Anchordoguy 1989; Best 1990:chs.5-6].

The Japanese state has been able to play this role because it presides over (and is the product of) a culturally homogenous population that, as evidenced by the Meiji restoration and subsequent economic reforms, engaged in the process of industrial development in a remarkably consensual manner. The lack of prior industrial development even in the later Tokugawa period, compared with Britain, United States, and Germany in mid-nineteenth century, meant that the Japanese state had no choice but to promote the education and enterprise that would generate a broad-based system of skill formation.

Although, in the late nineteenth century, the Japanese state consciously pursued an economic development strategy, it relied on private-sector enterprises to formulate the investment strategies and implement the organizational structures that would generate innovation and growth. The State did, however, make critical investments in the educational system, so that within two decades after the Meiji Restoration, the Japanese system of public education was virtually universal and the system of higher education was turning out a steady supply of engineers who then acquired specialist skills working for private-sector companies that were building managerial structures [see Odagiri and Goto 1993].

A fundamental institution of Japanese capitalism is the enterprise group, or keiretsu. The original enterprise groups in modern Japan were the family-controlled zaibatsu that led the development of heavy industry -- particularly iron and steel and shipbuilding -- from the turn of the century until World War II. Some of the most important zaibatsu originated through the efforts of political-entrepreneurs, who used their connections to the Meiji government, that was bent on fostering industrial development, to gain privileged access to resources and rights (such as minerals and transportation) that were crucial to Japan's development strategy. To make good on their leading roles in Japanese economic development, the zaibatsu families

delegated substantial decision-making power to professional managers who used this power to build formidable managerial structures [Morikawa 1992].

In the aftermath of World War II, the Allied occupation forced the dissolution of the zaibatsu by implementing the widespread distribution of equity shares, while leaving the constituent enterprise groups intact. In the 1950s, the Japanese business community undertook a "cross-shareholding movement" to ensure that ownership rights in companies would reside with other industrial and financial companies, that would act as "stable shareholders", seeking neither high yields nor capital gains on their equity positions. Rather, cross-shareholders hold the shares for the sake of ensuring reinvestment in industry in general, which over the long rung generates more business for the companies in the activities in which their competitive advantages lie [Ballon and Tomita 1988; Gerlach 1992; Miyajima 1994].

Since World War II, the largest of these corporate entities -- Mitsubishi, Mitsui, and Sumitomo -- shorn of family control, have remained powerful corporate actors in the Japanese economy, along with a few other large groups built up either by powerful banks or by industrial enterprises that have emerged as dominant in their industries. In the automobile and electronics industries, for example, Toyota and Sony have spawned vertical keiretsu through which they plan and coordinate of group activities, including the creation or acquisition of new vertically related enterprises as the need arises. Enterprise groups permit the core companies to enjoy the advantages that the vertical integration of production and distribution creates for the borrowing of technology and the implementation of process and product innovation, without enduring the disadvantages of unmanageable bureaucracies that stifle technological and organizational change. By circumventing the intrafirm organizational structure through subcontracting arrangements with satellite firms, the core company can pursue new investment strategies that require entrepreneurial initiative and leaps in technological ability.

The growth of enterprise groups provides core companies with the opportunity for strategically locating more labor-intensive activities in smaller firms in which the technical specialists have direct proprietary interests in enterprise performance, and in which control of the terms of employment and work conditions need not be shared with the enterprise unions that have become central to labor-management relation in the dominant companies. Although as subcontractors for the core enterprises, the satellite firms can in principle act independently, in practice the very success of the innovative strategies of the dominant enterprises and their commitment to maintaining long-term relations with their subcontractors leads the smaller firms to view themselves as members of an integrated organizational structure [Dore 1986; Best 1990: ch.5; Smitka 1992].

Over time, some of these "satellites", if successful, have taken on lives of their own, as in the case of Fanuc, the company set up by Fujitsu to develop numerical control units for machine tools [Collis 1988]. Even then, the very fact that one strong vertically related enterprise has emerged out of the development of another creates a continuing basis for cooperative investment policies while each builds its own internal organization. The organizational capability developed through intercompany cooperation within groups undoubtedly enhances the ability of firms from different groups to engage in cooperative research and development projects, as has been the

case in the emergence of an internationally competitive Japanese computer industry [Anchordoguy 1989].

The ability to organize cooperative investment strategies across enterprises is enhanced by the structure of managerial decision-making within enterprises. Consensus decision-making -- the ringi system -- emphasizes the two-way flow of ideas and information up and down the corporate hierarchy. Consensus decision-making grew out of the need of the rapidly growing zaibatsu of the early twentieth century to lure college graduates -- products of a concerted effort by the state to create on educated elite -- away from prestigious government posts. Considerable technical information was required from, and considerable authority had to be delegated to, these professional managers. Even in the cotton textile industry, which in Japan as in Britain and United States played a major role in early industrialization, the recruitment of college graduates to serve as mechanical engineers was central to the achievement of high levels of productivity on the basis of inexpensive cotton and unskilled labor [Yonekawa 1984; Morikawa 1989; Mass and Lazonick 1990; Lazonick and Mass 1994].

The institutional basis for the devolution of decision-making power from chief executives to a wider group that extends further down the formal hierarchy is permanent, or lifetime, employment. Japanese managers typically rise out of the ranks of "white-collar workers" who enter the firm after graduating from college. Like consensus decision-making, the policy of permanent employment was extended to professional managerial personnel in the early twentieth century in order to attract them away from government service and to create the long-term attachments that would make it worthwhile for the business enterprises to invest further in the training of the recruits [Daito 1986].

Over time, however, the offer of permanent employment has been extended further down the organizational hierarchy. Before World War II permanent employment was used as a strategy to transform "key" skilled workers (oyakata) who, as highly mobile labor contractors, had recruited, trained, and supervised shop-floor labor, into permanently employed foremen who now performed the same functions, but with a long-term commitment to one particular company [Okayama 1983; Gordon 1985]. In the early 1950s a strategy of substituting cooperative enterprise unions for the militant industrial unions that had arisen after World War II resulted in the extension of permanent employment status to all male blue-collar workers in the larger enterprises [Cusumano 1985:ch. 3].

The recent success of Japanese mass producers in introducing flexible manufacturing systems owes much to the fact that, for decades before the introduction of the new automated technologies, blue-collar workers were granted considerable discretion to monitor and adjust the flow and quality of work on the shop floor [Cusumano 1985:ch.5-6]. Moreover, the ability of Japanese managers to develop the skills of blue-collar workers owes much to the existence for over a century of a national system of mass education designed specifically to ensure that the workforces of the future will possess the general cognitive competence that advanced production technology requires [Odagiri and Goto 1993; Dore and Sako 1989].

Japanese practice is in marked contrast to the U.S. managerial concern with using technology to take skills and initiative off the shop floor, a practice that goes back to the late nineteenth century when the success of U.S. mass production was dependent upon breaking the power of craft workers and transferring to management the sole right to plan and coordinate the flow of work. Despite the existence of militant unionism in Japan at various points in the first half of the twentieth century, there was never any attempt by Japanese workers or their organizations to establish craft control on the shop floor [Gordon 1985: Part 1]. As a result, Japanese employers never had to confront established craft positions of workers as was the case with U.S. manufacturers around the turn of the century, nor did they have to resign themselves to simply leaving skills on the shop floor in the hands of autonomous craftsmen as was the case in Britain.

Historically, the problem facing Japanese employers was not to rid themselves of skilled workers who might use their scarce skills to establish craft autonomy on the shop floor. Rather their problem coming into the twentieth century was the absence of a self-generating supply of workers with industrial skills. To overcome this constraint, industrial employers had to make the investments that would transform unskilled workers into skilled workers and then retain them by integrating them into the organization. To be sure, these same employers generally only accepted the institutionalization of permanent employment, enforced by enterprise unions, when compelled to do so by the threat of militant unionism after World War II. In practice, however, out of the exigencies of developing and utilizing workers with industrial skills, the social foundations for the current permanent employment system were laid in Japan decades before the long-term commitment of the enterprise to the blue-collar worker became an institutional feature of Japanese industry.

Skill formation and competitive advantage

In terms of the organizational integration of management and labor, the Japanese system of skill formation is most similar to that of Germany. In both nations, skill formation on the shop floor is integral to the strategy and structure of skill formation in the enterprise as a whole. In Germany, however, the skill-formation structure of the enterprise derives from an industry-wide strategy to set high-quality product standards, whereas in Japan the skill-formation structure derives from an enterprise strategy to engage in continuous problem-solving to cut costs. In Germany shop-floor workers are trained to perform to precise occupational standards, whereas in Japan shop-floor workers are trained to perform many tasks that will enable them to recognize and confront production problems as they arise. In historical perspective, the German system of skill formation reflects a tradition of producing for markets that demand high quality, whereas the Japanese system reflects a tradition of producing for markets that demand low cost.

The German and Japanese systems of skill formation also differ in the ways in which they are shaped by and diffuse to large and small manufacturing companies. In Japan, large and small companies tend to be vertically linked through enterprise groups, with the strategy for skill formation issuing from the dominant enterprise but extending to smaller subcontracting firms. In Germany, the industry-wide, and even nation-wide, character of the strategy and structure of skill formation means that the system extends to both large and small companies, whether they are vertically linked or not. Notwithstanding regional variations within Germany, the German system of skill formation appears to be driven as much by the needs of the Mittelstand as by those of major industrial corporations such as Siemens, BMW, and BASF.

Although shaped by different product-market orientations, by making skill formation on the shop floor central to their investment strategies, both the German and Japanese systems differ markedly from the American system. In the American case, the shop-floor investment strategy has been to substitute machines and materials for the skills of workers. What all three systems -- the German, Japanese, and American -- have in common, however, is investment in managerial structure as the historical precondition for the shop-floor investment strategy, whether it be skill-creating as in Germany and Japan or skill-destroying as in the United States. And all three systems differ from the British case in having a strategy and structure of skill formation at the managerial level.

What are the implications of these different systems of skill formation for changes in international competitive advantage? In the post-World War II decades, Japanese enterprises gained competitive advantage over American enterprises in those industries such as steel, consumer electronics, and automobiles in which an integrated system of skill formation within the managerial structure was critical for product innovation, but also in which the evolution of process technology made an integrated system of skill formation that included shop-floor workers and suppliers was critically important for process innovation. In industries in which, from the 1960s, a system of skill formation that focused on the managerial structure alone

continued to suffice in global competition -- industries such as pharmaceuticals and chemicals -- the Americans continued to be leading innovators, and Japanese companies were unable to mount an effective competitive challenge [for an elaboration of this argument, see Lazonick and West 1994 forthcoming].

Indeed, in industries such as pharmaceutical and chemicals, the system of skill formation that generates organizational learning and innovation includes tight research and development linkages with universities, a set of relationships that has long prevailed in Germany and United States, but not in Japan. In Germany, these industry-university linkages are part of a national system of skill formation designed to generate high-quality products without the achievement of low unit costs being a primary concern. In machine-based industries, however, where process innovation has been important in driving down costs, the Japanese have been able to use their highly integrated systems of skill formation to generate the organizational learning that has permitted them over time to move into high-quality market segments at lower unit costs than their high-quality competitors. Some two decades ago, the Japanese used their process innovations to displace Germans in the high-quality camera and binocular markets. Today, Japanese companies are mounting the same effective competitive challenges to Germany in the machine tool and luxury automobile markets.

Considering the four national economies in terms of both quality and cost (and with obvious oversimplification), Britain can now be characterized as a low-quality, high-cost producer, United States as a low-quality, low-cost producer, Germany as a high-quality, high-cost producer, and Japan as a high-quality, low-cost producer. In both Britain and the United States, the dominant response to the Japanese challenge has been to seek to remain competitive by restraining wage increases and increasing labor effort (in large part as a concomitant to downsizing), with a neglect of investments in skill formation that are essential for raising living standards and improving employment conditions over the long term. As the Japanese challenge has begun to make itself felt in Germany (as well as in other economies of continental Europe), similar adverse pressures on wages, effort, and investments in skill formation are becoming manifest.

The British and American experiences have shown that, in response to the pressures of global competition, strategic decision makers have a tendency to turn from making value-creating investments in skill formation that can generate higher quality, lower cost products in the future to implementing value-extracting strategies that permit those who control resources to live off the value-creating investments made in the past [see Lazonick 1994b]. Financial interests exert much more pressure on British and American strategic decision makers in industry to treat the process of skill formation not as a productive investment that can generate returns in the future but as an operating expense that depresses returns in the present.

The power of financial interests to stress short-term profits as the goal of the firm has confronted the power of managerial interests to invest in, and restructure, skill-formation systems when the systems that previously generated sustained competitive advantage in the past have ceased to do so. An understanding of the importance of the process of skill formation to economic development and international competitive advantage raises critical questions about the valuation of human-capital

investments in capitalist economies, who has an interest in making these investments, and in whom these investments are made. Especially when, as is the case in Britain and United States, and increasingly in Germany, existing systems of skill formation are under intense competitive pressure, policies for industrial restructuring must consider the modes of corporate governance (and underlying changes in political alignments) that are required to put new, more innovative, systems of skill formation in place.

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STEP group

STEP-gruppen ble etablert i 1991 for å forsyne beslutningstakere med forskning knyttet til alle sider ved innovasjon og teknologisk endring, med særlig vekt på forholdet mellom innovasjon, økonomisk vekst og de samfunnsmessige omgivelser. Basis for gruppens arbeid er erkjennelsen av at utviklingen innen vitenskap og teknologi er fundamental for økonomisk vekst. Det gjenstår likevel mange uløste problemer omkring hvordan prosessen med vitenskapelig og teknologisk endring forløper, og hvordan denne prosessen får samfunnsmessige og økonomiske konsekvenser. Forståelse av denne prosessen er av stor betydning for utformingen og iverksettelsen av forsknings-, teknologi- og innovasjonspolitikken. Forskningen i STEP-gruppen er derfor sentrert omkring historiske, økonomiske, sosiologiske og organisatoriske spørsmål som er relevante for de brede feltene innovasjonspolitikk og økonomisk vekst.

The STEP-group was established in 1991 to support policy-makers with research on all aspects of innovation and technological change, with particular emphasis on the relationships between innovation, economic growth and the social context. The basis of the group's work is the recognition that science, technology and innovation are fundamental to economic growth; yet there remain many unresolved problems about how the processes of scientific and technological change actually occur, and about how they have social and economic impacts. Resolving such problems is central to the formation and implementation of science, technology and innovation policy. The research of the STEP group centres on historical, economic, social and organisational issues relevant for broad fields of innovation policy and economic growth.